MSNE 311 Materials Selection and (Nano)Engineering

Offered each Spring Semester.

Materials Selection – An interdisciplinary science/engineering and design course focused on Materials Selection and Engineering methods and problems. This course offers students the opportunity to learn about different classes (types) of materials and to take what they have learned in basic Materials Science courses and courses in chemistry, physics, and mathematics and apply that knowledge in selecting materials for a range of applications. In this course, an emphasis on properties of materials is coupled to design of components and systems and to solving engineering problems. Students will have homework and a project to demonstrate their knowledge of material presented in this course. This course is required for MSNE majors in the BS program.

- Instructor: Enrique V. Barrera Office: MEB 237 ebarrera@rice.edu
  Office hours: After class or by appointment. Course meets MW 2:30 to 3:45pm
- Prerequisites: MSNE 301 or currently in MSNE 301. Students must have had Chemistry, Physics, and Mathematics or be taking them concurrently.
- Text: No text is required for this semester.
- Grading:
  1. Materials Selection 10%
  2. Semester long project 70%
  3. Materials concepts and properties 10%
  4. Engineering specifications 10%
- Honor Code: Quizzes and exams are individual work and must include the Rice Honor Pledge. Homework can be discussed with others but students must turn in their own work. Points will be deducted for items turned in late.
- Absence Policy: Any extension of time for homework assignments and the project must be approved by the instructor prior to the due date and with good cause (determined by the instructor).
- References: The instructor may provide reference material and you may be advised to use material from the Internet and/or the library. These references bust be cited according to ACS format.

Lecture Topics

- The Design Process
- Engineering Materials and their Properties
- Ethics in Engineering
- Engineering Systems
- Materials Selection
- Materials Processing and Design
- Case Studies in Materials Selection
- Sources of Materials Property Data
- Structure/Property Relationships
- Materials, Aesthetics, and Industrial Design

Goals for this Course
To address ABET Student Outcomes and program Criteria, students will have
c) an ability to design a system, component, or process, to meet desired needs with realistic constraints…
e) an ability to identify, formulate, and solve engineering problems
j) a knowledge of contemporary issues

And the course will prepare graduates as follows:

To take on design projects and work through the various steps in a design process to achieve outcomes that include producing a prototype system or component and to present your design and prototype to interested parties. To take steps for conducting materials selection and for conducting materials selection where engineering specifications are required.

More Specifically students should have the ability to communicate their ideas and problem solving to others and to produce realistic engineering outcomes with constraints such as cots and within required times.

Each course is connected to the following questions:

First, see the following problems:

Problem 1. Materials Selection (10%)
1. (2.5%) Make a table of glass materials that shows percentage of the market, material additives, specialty properties, processing used to achieve the desired properties, what the glass is used for and who are the major producers.
2. (2.5%) Write a short paper with figures and references on what gives glass its strength. What features reduce strength and how are these approaches overcome. In this paper, include a table that lists the strength of glass, fracture toughness of glass, and various properties of flexure, impact strength.
3. (5.0%) Select a glass material for an architectural application. The application is glass to be used on a new airport in Houston, TX. This airport will serve a growing population on the west side of Houston in the Katy, TX area. In an application like this there are a number of factors to consider along with specifications that need to be addressed. This problem will be focused on how extensive you complete your design and how much detail you include in the choice of the glass and in its installation.

Due on January 26th at 5:00pm

Problem 2 (Semester long project) (70%)
Produce an energy device that either harvests, stores or converts energy. The best device needs to have the highest efficiency for the lowest cost. This project focuses on energy materials.
Grade assessment for the problem:

a) Proof or demonstration of your design	20%
b) Gantt Chart, Parts list, and Flow Chart	10%
c) Progress reports on a weekly basis (participation)	10%
d) Final Presentation	10%
e) Final Report	10%
f) Self evaluation	10%

Due at the end of the semester (last week of classes).

Problem 3. Materials Concepts and Properties (10%)
Steel is a common material that has been researched and developed for years. There are commodity steels and specialty steels and in many cases it's the specialty steels that dominate today's markets. (2.5%) Look up the various types of steels and make a table of the various types. List key properties and materials additives associated with those properties. (2.5%) There are several key materials concepts that define steels. Identify them and connect them to various steel types. (2.5%) There are specific

equations associated with these materials properties, write them and show how these equations help us understand the properties (in short, show key examples with data). (2.5%) Select a steel for armoring an umbilical cable to be used in offshore applications. Explain its use and the type of steel used. Important details are critical here.

Due on February 23rd at 5:00pm.

Problem 4. Meeting Specifications (10%)

Typically in engineering operations, the materials for use must meet certain specifications and requirements. In many cases, when testing to certify or qualify materials is a requirement, standards are used. Each industry has their own set of standards and requirements. In this problem, we will address standards and specifications.

(2.5%) I will give you three standards to study and to identify key elements of the standards. (a) Consider the science and discuss the details as to how it isolates the property that the test is probing. Also address why the test is taking the steps it takes to insure reproducibility. (2.5%) (b) Contact a local company that is willing to share their materials specifications with you. Lookover these specifications and discuss the various properties they address in order of priority. Look at what might be considered for secondary specifications and discuss this as to properties. If the company did not specify this, decide on what is primary and secondary and explain your thinking. (5.0%) (c) Write specifications for the following engineering situation: In Houston, we see constant road work on the city streets. This is because of repair to public works located under these streets. Write specifications for the various public works and write new specifications that would help in reducing the number of repair activities.

Due April 6th at 5:00pm.

For ABET assessment:

c) an ability to design a system, component, or process, to meet desired needs with realistic constraints…
    Problem 3. Materials Concepts and Properties
    (2.5%) Select a steel for armoring an umbilical cable to be used in offshore applications. Explain its use and the type of steel used…

e) an ability to identify, formulate, and solve engineering problems
    Problem 1. Materials Selection
    (5.0%) Select a glass material for an architectural application…

j) a knowledge of contemporary issues
    Problem 1. Materials Selection
    (2.5%) Make a table of glass materials that shows percentage of the market, material additives, specialty properties, processing used to achieve the desired properties, what the glass is used for and who are the major producers.

References

Notes from Dr. Barrera and content put on Owlspace.

Note: Any student with a disability requiring accommodations in this class is encouraged to contact the instructor after class or during office hours. Additionally, students should contact the coordinator for Disabled Student Services in the Allen Center.